The Dynamics of the South China Sea Warm Current (SCSWC)

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LONG-TERM GOALS

The western boundary region of the North Pacific Ocean is unique in that it is porous. Massive exchanges between the Pacific and the marginal seas occur through gaps in the island chain that bounds the open basin. The long-term goal of the work is to understand the dynamics of these exchanges and their consequences in terms of ocean variability.

OBJECTIVES

The dynamics of mesoscale flow features that arise from the disruption of the Kuroshio and its branches by the continental margin topography is the focus of the research. The purpose is to seek an in-depth understanding of the dynamics and ramifications of these features.

APPROACH

The examination and interpretation of current-meter, hydrographic, and remote-sensing data have continued. In addition, the output of the eddy-resolving, general circulation model of the Asian marginal seas developed in part in an earlier project is analyzed to expose the dynamic of the circulation concerning the Kuroshio/topography interaction. Isolatable dynamic issues are addressed with analytical models.

RESULTS

(1). The collision with the continental margin off the southern coast of China of the inflow branch of the Kuroshio loop through the Luzon Strait gives rise to, in a steady-state, a splinter current (South China Sea Branch of Kuroshio)(SCSBK) to the southwest along the upper slope and to a pressure distribution along the shelf break that is conducive to the formation of a shelf-break countercurrent (South China Sea Warm Current) (SCSWC) to the northeast. The SCSBK appears to sustain the SCSWC by feeding water mass to it. Figure 1 shows the sea-surface height distribution and barotropic velocity vectors in the region west of the Luzon Strait calculated from the Asian marginal seas model without the wind stress (Hsueh, 2000). The SCSBK and the SCSWC are clearly discernible in the vector field. There is a high pressure tongue, separating the SCSBK and SCSWC, that fades southwestward along the upper slope until 113E, suggesting a slow onshore flow from the SCSBK toward the SCSWC. The high pressure patch found beyond 113E is probably due to the blocking of the flow by the land mass at 111E that is suppose to represent the Hainan Island.

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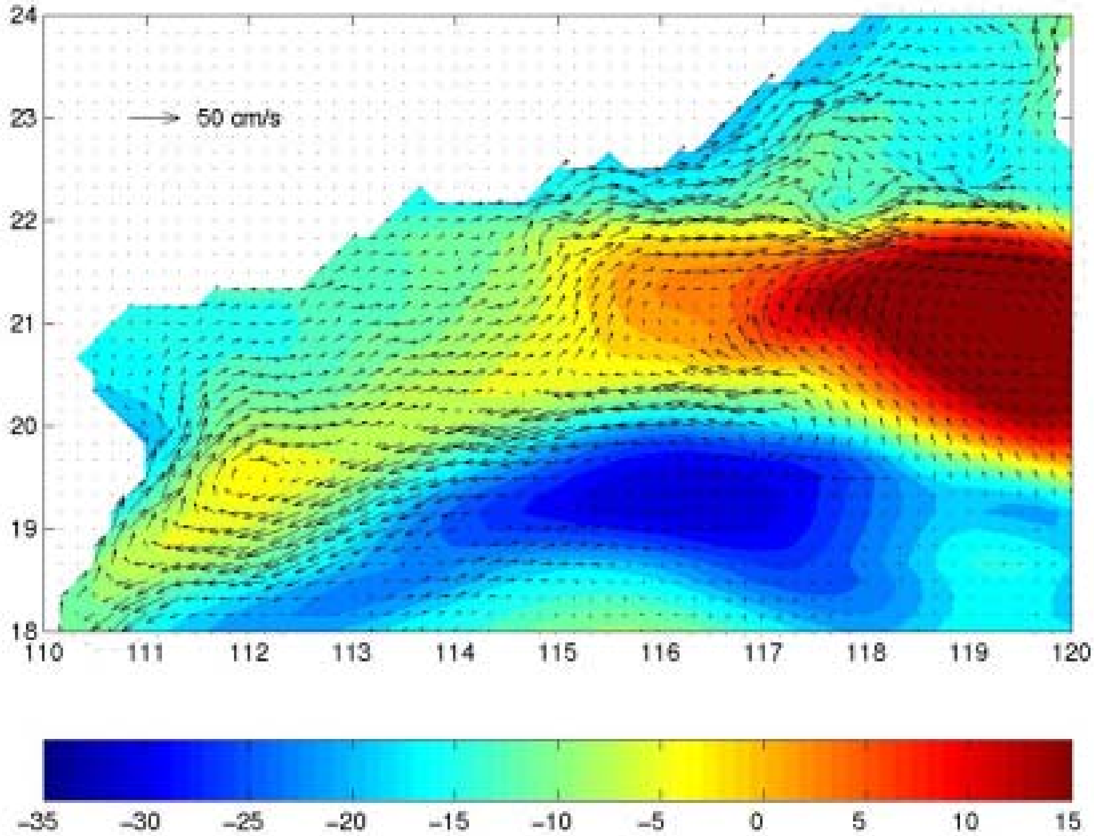

Fig. 1. Horizontal barotropic velocity vetors overlying color-coded sea-surface height field in the northern South China Sea from the output from the Asian marginal seas model at the end of a four-year run with no wind stress. The model is driven by an imposed Kuroshio inflow (50 Sv) at 15N. A high-pressure tongue between the SCSBK offshore and the SCSWC inshore originates from near the Dongsha Island at around 116E and 21N and fades to the southwest along the continental shelf edge.

(2). The flow deflection involved in the collision of the Kuroshio with the continental margin that gives rise to the SCSBK is accounted for, in an analytical model, with the inclusion of coastal topography. The relative vorticity generation due to the shoaling coastal water detracts from the deflection to the left, facing the coast, and makes the size of the SCSBK transport in line with the observation (about 9% of the Kuroshio transport off Luzon Island (Nitani, 1972; Zhong, 1990)). The theoretically calculated alongshore pressure distribution, low to the right and high to the left of the stagnation region, facing the coast, induces a frictional flow on the continental shelf that resembles the SCSWC.

IMPACT/APPLICATIONS

The flow deflection of the Kuroshio colliding with the continental margin as a concept for the explanation of the SCSBK and SCSWC provides a basis for the generation of a west boundary current that is responsible for heightened mesoscale variability along the northwest margin of the South China Sea (Wang et al., 2000). In addition, as the SCSBK water mass is uplifted across the shelf break, water of high nutrient concentration is brought to the SCSWC, making the latter highly biologically productive.

TRANSITIONS

The work has provided the theoretical basis for a joint current meter mooring experiment with Dr. David Tang of the National Taiwan University and Dr. Neal Pettigrew of the University of Maine, in which four moorings were deployed in November, 2001 across the shelf break from (113^{o}42'E, 20^{o}51'N) to (114^{o}19'E, 20^{o}00'N) to capture the SCSWC.

RELATED PROJECTS

The projects of Dr. David Tang and Dr. Neal Pettigrew.

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PATENTS

None.